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English

TOWARD AN INTERNATIONAL LUNAR POLAR VOLATILES STRATEGY.

Fourteen international space agencies are participating in the International Space Exploration Coordination Group (ISECG), working together to advance a long-range human space exploration strategy. The ISECG has developed a Global Exploration Roadmap (GER) that reflects the coordinated international dialog and continued preparation for exploration beyond low-Earth orbit, beginning with the Moon and cis-lunar space, and continuing to near-Earth asteroids, and Mars. In regards to exploration of the Moon, the initial missions and capabilities on the lunar surface will likely consist of small robotic missions limited in scale and mission duration, with everything needed for those missions delivered from Earth. However, when it comes to maintaining a longer-term human presence beyond low-Earth orbit, space agencies agree that the use of local resources could significantly benefit operations in the lunar vicinity, and possibly limit the cost and complexity of bringing all the needed supplies from Earth. The most promising uses for local resource utilization are in life support systems or as propellants. For many years, the lunar regolith was seen as the primary source for both oxygen (chemically bound in lunar minerals and glasses) and hydrogen (implanted into the regolith by the solar wind). However, the recent discoveries of water on the Moon, particularly in polar regions, may lead to less complex methods to create life support consumables and propellants. To gain an understanding of whether lunar polar volatiles, such as water ice, could be developed and used in a cost effective and safe manner, it is necessary to understand more about the nature and distribution of the volatiles and operating in the lunar polar environment. As the volatiles on the Moon are associated with the lunar regolith, new planetary mining technologies such as roving, prospecting, regolith excavation, resource processing, and product storage will be required. Technologies to operate in the lunar polar environment, such as power generation, communications, and thermal management will also need to be developed and tested. Scientists have discussed the possibility of water ice existing in lunar polar regions since the early 1960s. However, it wasn't until the 1990's that lunar orbiting spacecraft began acquiring the data to support such a hypothesis. The Lunar Crater Observation and Sensing Satellite (LCROSS) provided direct evidence of the presence of water ice in a permanently-shadowed portion of Cabeus crater in 2009. However, evidence of water ice in the lunar polar regions does not exhibit a spatial correlation with all permanently-shadowed areas on the Moon, as is suggested on Mercury. Further spacecraft missions have shown that water exists on large portions of the lunar surface as a thin layer of surface-bound hydroxyl and/or water molecules, and could be a possible source of water for polar ice deposits. Understanding the quantity, distribution and form of lunar polar volatiles, including water ice, and pursuing the scientific questions regarding the creation, transport, delivery and accretion of water and water ice on the Moon are considered as strategic knowledge gaps by the ISECG. The ISECG has begun an effort to develop a coordinated international lunar polar volatile strategy that is technically feasible, yet programmatically implementable. The strategy would follow an incremental phased approach, beginning with robotic prospecting to understand the nature and distribution of the polar volatiles through measurements on the lunar surface, and followed by robotic in situ resource utilization (ISRU) demonstrations to understand whether potential resources could be extracted and processed economically and safely. Currently, there are three initial core elements to this strategy. 1.) Lunar Regions of Maximum Interest - build a consensus among the international community for 'common regions' on the lunar surface to be collectively explored by a variety of sequential, coordinated missions. The regions would be larger than a landing site for a single mission, perhaps areas as large as several tens of kilometers in extent, and possibly including highly illuminated peaks and permanently shadowed areas. 2.) Low Entrance Barriers - facilitate participation by space agencies, commercial entities, and universities by deployment of surface or orbital infrastructure assets that provide productivity-enhancing utility services within the specified region (i.e., power generation, thermal protection, communication) to allow for simpler, lower cost rovers or other surface systems; and collaborative development of instrument or surface system capabilities between participants. 3.) Common Standards – utilize standard interfaces (mechanical, electrical, communication) and standard propellants to optimize use of surface utility services, permit interchangeability of vehicle payload complements, and maximize interoperability.

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